Developing and evaluating technology for people with cognitive impairments

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Outline

• Designability - our mission
• Introduction to assistive technologies
• Review of the evidence base for the technology
• Case study 1 – time orientation
• Case study 2 – prompting
• Case study 3 – independent living with smart technology
• New technology for cognitive and emotional rehabilitation
New product development - with your insights
we create innovative products that look good and make a difference
With your support we research and develop assistive technologies that enhances lives
Assistive technology…
Assistive or enabling technology

- Reducing the demands from the environment
- Environmental demands
- User Ability
- Improving functional ability
- Everyday activities
Long term effects of Acquired Brain Injury

• Cognitive
  – Long and short term memory, planning, task sequencing

• Behavioural
  – Lack of self awareness, executive dysfunction
Efficacy and usability of assistive technology for patients with cognitive deficits: a systematic review. de Joode et al 2013

- Twenty-eight papers presenting 25 studies were reviewed. The total number of participants was 423. Most identified papers described case reports or non-randomized clinical trials.

- The efficacy of assistive technology in general is not yet sufficiently studied.

_Clin Rehabil._ 2010 Aug;24(8):701-14
Cognitive function and assistive technology for cognition: a systematic review  Gillespie et al 2013

• 89 publications reporting 91 studies of an ATC intervention
• support cognitive functions relating to attention, calculation, emotion, experience of self, higher level cognitive functions (planning and time management) and memory
• framework for ATC prescription, classification system, recommends areas for research

Fig. 3. Number of studies in each ICF cognitive function category by ISO technology category.
Fig. 6. Number of studies in each clinical population by assistive technology function.
Prospective memory rehabilitation using smartphones in patients with TBI  Wong 2016

• Uncontrolled pre- and post-assessment design
• Thirteen participants, 6-week group-based intervention
• Pre-, post- and 2-month F/U by questionnaires and daily assessment of target behaviours for 2-week periods
• Significantly fewer retro- and prospective memory problems reported on questionnaires after the intervention
• Insignificant improvement in performance of target behaviours

‘This study adds to a growing body of evidence that smartphones are a useful compensatory aid in rehabilitation of prospective memory that should routinely be considered in rehabilitation of TBI patients.’

Wong et al Disability and rehabilitation. 2016
The efficacy of cognitive prosthetic technology for people with memory impairments: a systematic review and meta-analysis. Jamieson 2014

- Scales were used to compare each study to an ideal single case experimental design, or randomised control group study
- Meta-analysis of the efficacy of technology vs. control in seven group studies gave a large effect size ($d = 1.27$) ($n = 147$)
- Prosthetic technology can improve performance on everyday tasks requiring memory

Text messages reduce memory failures in adults with brain injury: A single-case experimental design  Cruz 2016

- Two single-case experimental designs with multiple baselines across activities
- Participants were taught how to send reminders through Google Calendar to their mobile phones.
- Target activities were selected using the Canadian Occupational Performance Measure.
- Improved self-perception of performance and satisfaction levels.
- Non-overlap of all pairs statistical analysis, most, but not all, target activities showed statistically significant improvement, with non-overlap ranging from 47% to 98%.

‘The reminder system was effective in increasing the frequency of completion of routine activities of daily living. ‘

Cruz 2016  BJOT
Goals of rehabilitation and assisted living

- Safety
- Self care / activities of daily living
- Health and wellbeing
- Activity / Mobility
- Communication
- Memory and orientation
- Mood behaviour
- Motivation
- Community participation
### International Classification of Functioning Disability and Health

<table>
<thead>
<tr>
<th>Body Functions &amp; Structures</th>
<th>Activities &amp; Participation</th>
<th>Environmental Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functions</td>
<td>Capacity</td>
<td>Barriers</td>
</tr>
<tr>
<td>Structures</td>
<td>Performance</td>
<td>Facilitators</td>
</tr>
</tbody>
</table>

[Designability Logo]
Technology and outcome evaluation

1. Technical performance
2. Qualitative – diaries, interviews, reports
3. Quantitative measures - occupancy data, hours use, number of incidents
4. Quantitative assessment tools – COPM, GAS
5. Cost effectiveness
Case study 1 – time orientation

- 62 year old man with memory problems following TBI
- Problems – short term memory, orientation, judgement
- Overnight forgets what day it is, more confused in the morning, relies on carer
Goals - time orientation

Goals for person
Disorientation following sleep
Determine day/night, Reduce missing events
Reduce prompting to do tasks / enable independence

Themes for carer
Reassurance, Reduce questions/phone calls
Determine day/night (less time taken & more sleep for carer)
Reduce missing events

http://www.day-clock.com/
Evaluation – time orientation, 6 week F/U

• Goal 1
  • Find out for himself if it is the morning and what day it is   Fully met

• Goal 2
  • Independently getting on with his weekly routine without prompts  Partially met

• Carer goal
  • Less tension in our relationship   Fully met

‘less tension in the relationship ‘ ‘hassle free, just works’
## Memory technology library – time orientation study

<table>
<thead>
<tr>
<th>Order of importance</th>
<th>Goals for person living with memory loss or dementia</th>
<th>Goals for carer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Determine day/night</td>
<td>Reduce questions/phone calls</td>
</tr>
<tr>
<td>2.</td>
<td>Reduce missing events</td>
<td>Reassurance for user &amp; carer</td>
</tr>
<tr>
<td>3.</td>
<td>Reduce prompting to do tasks / follow routine (food &amp; medication) / enable independence</td>
<td>Reduce conflict</td>
</tr>
<tr>
<td>4.</td>
<td>Disorientation following sleep</td>
<td>Determine day/night (less time taken &amp; more sleep for carer)</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Reduce missing events</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Reduce prompting to do tasks / follow routine (food &amp; medication) / enable independence</td>
</tr>
</tbody>
</table>

[Designability logo]
MTL Day Clock - were the goals met?

Graph shows results for all goals. User (Goal 1 & 2) & carer (Goal 3)

Data from 71 replies
Case study 2 – audio prompting

- Michael 62-year old in patient rehabilitation
- Intra-cerebral haemorrhagic stroke.
- Persisting severe cognitive difficulties in memory, executive functioning and visual perception.
- Regular night-time wandering with confusion, topographic disorientation and apparent distress and irritability when approached.

Can audio prompting be used to modify behaviour?
Evaluation

A movement-activated prompt was introduced in the intervention phase to reassure, direct him to the bathroom or encourage return to bed. 0:00-07:00am

ABA single case design

Just checking motion detector to record activity through the night
Case study 2 - results

**Baseline** 112 events in 19 days (Range 1-11)

**Intervention** 44 events in 29 days (Range 1-4)

**Wander-Reminder removed** 21 events in 25 days (Range 1-3)

pamela.brown@thedtgroup.org
Case study 3 – Activities of daily living

RK, 22-year old, male with TBI
1.5 year post-TBI
14 months in rehab

PT, 43-year old, male with non-traumatic ABI
2.4 months post-ABI
3.5 months in rehab

Sara d S Ramos, N Harris and Mike Oddy AAATE 2013
<table>
<thead>
<tr>
<th>Needs</th>
<th>Goals</th>
<th>AT solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal care</td>
<td>• Hygiene</td>
<td>Monitor shower usage</td>
</tr>
<tr>
<td>Domestic skills</td>
<td>• Managing cooking appliances</td>
<td>Prompts to turn appliances off + staff alerts</td>
</tr>
<tr>
<td>Safety &amp; wellbeing</td>
<td>• Stranger danger</td>
<td>Prompts + alerts</td>
</tr>
<tr>
<td></td>
<td>• Returning home</td>
<td>Occupancy data</td>
</tr>
<tr>
<td></td>
<td>• Staying home at night</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Functional routine</td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td>• Taking belongings</td>
<td>Prompts when leaving</td>
</tr>
</tbody>
</table>
Evaluation of outcomes and technology

1. Log of all requests to 24-hour support staff
2. Record of all pager alerts
3. Analysis of occupancy data
4. Service user / staff experience of interacting with smart environment
5. Ease of use of the technology
Smart home - a building with integrated technology that supports and assists its users, increasing their independence and improving quality of life.
Effectiveness of independent living

**RK**
- Sought assistance for complex activities and needed prompting for cleaning, etc.
- Positive response to kitchen and key reminders
- Persistent problems with managing finances, social vulnerability, running a home, coping with unplanned events

**PT**
- Relatively independent for most activities, except meal preparation
- Positive response to kitchen reminders
- Reduced number of pager alerts to staff
- Persistent difficulties with meal preparation, managing diabetes
Users evaluation

RK
• Keen and positive reaction to technology
• ... But eager to say what we want to hear

PT
• Initially unenthusiastic
• Later acknowledged helpfulness of prompts

STAFF
• Initially cautious and nervous
• Eventually acknowledged usefulness to highlight service user’s needs
The system is expensive
Must be wired into the house
Difficult to set up and programme
Expert assistance is required to install and maintain the system
Home Automation

Motorola Smart Monitoring
Up to 50% Off
SHOP NOW

Piper Security
Up to £60 Off
SHOP NOW

Netatmo Presence
Outdoor Security Camera
£249.99
SHOP NOW

267 Products found
Home Automation

New to home automation?

Have a read of our starter guide here, which will give you some ideas on what you can do and which of the many different technologies may be right for you.

Adding to your current system?

You'll find a full range of Z-Wave modules, X10 modules, Home Easy / Smartwares / HomeWizard and Insteon modules available for next day shipping from our UK based warehouse.

CATEGORIES

Z-Wave Automation
devolo Home Control
Fibaro Automation
Home Easy - Smartwares
Insteon Automation
X10 Home Automation

SORT BY: Bestselling
WISP technology

• Service cloud platform – PC / mobile phone
• Z-Wave wireless link to the bridge
• Cellular internet connection
• PIR (occupancy)
• Door switches on every door (4)
• Luminance and temperature in all rooms (5)
• Humidity in the bathroom - shower detection
• Appliance monitors
  • Kettle, toaster, microwave, TV, bedside light, washing machine
  • Oven and cooker have remote switches
Client assessment - independent living

- Personal hygiene - Showers, Washing machine
- Sleep times and wandering
- Kitchen activities
  - Usage of cooker, oven, kettle, microwave, toaster (and times)
- Front door entry/exit
- Aggregate activity
  - In 6 hour slots (morning, afternoon, evening, night)
  - Long term averages (per resident)
- "forgetful" behaviours
  - Lights left on (after bedtime for example)
  - Doors left open (fridge, front door)
- TV - Times, durations
Summary data for client – day 1

Out of bed at 08:00
Kettle on at: 08:02, 08:26, 12:26, 16:59, 18:16, 20:03, 21:52
Toaster on at: 00:15
Microwave on at: 12:47, 19:33
No washing, oven, cooker, TV
Shower taken at: 13:55
Went to bed at 00:35 - bedroom lights still on, visit to the toilet

Activity levels - morning: Above average (104)
  Bathroom: 16%
  Bedroom: 21%
  Lounge: 25%
  Kitchen: 11%
  Hall: 25%
Goals of rehabilitation and assisted living

- Safety
- Self care / activities of daily living
- Health and wellbeing
- Activity / Mobility
- Communication
- Memory and orientation
- Mood behaviour
- Motivation
- Community participation
• Engage with clinical practitioners in the design and usability evaluation
• Support the practice of routine behaviours and social skills in real world settings
• To identify salient features of the environment for addressing therapeutic goals in a clinical rehabilitation setting

Zack Lyons, Leon Watts, Sara Da Silva Ramos
Benefit of Virtual Reality Environments

• Used to present challenges similar to those encountered in the real world
• Repeatable, post-session replays
• Reduced staffing and time requirements
Virtual environment

• Multiple errands test
• Increase levels of difficulty as behaviours and skills improve
• Audio and visual distractions, challenging characters
• Clinician interacts and directs the scenario
Interactions with a Challenging Character

https://www.youtube.com/watch?v=QxDqrmKDNfY
Challenges of Virtual Reality Environments

- VR motion sickness
- Acceptability of the environment
- Clinician interface
- Repeatability
- Real world generalisability
- Effectiveness as a rehabilitation tool
Summary

- There are a range of technologies available to rehabilitation and independent living of people with ABI
- Digital consumer technology is an key enabler
- There are good anecdotal and case reports of effectiveness
- We are beginning to develop an evidence base on effectiveness
- There are barriers
  - lack of awareness,
  - uncertain efficacy / cost effectiveness
  - user and/or carer acceptance
  - training of clinical support teams
  - availability of effective technology
Mainstream products
AT Dementia provides information on Assistive Technology that can help people with dementia live more independently.

- Share your experiences with others. Review a product or post a comment on our discussion forum.

Useful advice & product suggestions
Find out how technology can help you live well with dementia.

- Communication
- Safety
- Leisure
- Prompts & reminders

Try the new AT guide

Search our product directory
http://www.independentforlonger.com/
Pioneering approaches, research and practice: the new world of brain injury rehabilitation

27–28 September 2017

Hilton City Hotel, Glasgow
1 William St, Glasgow G3 8HT

#BIRT2017
Assisted Living Action Network (ALAN)

A group of organisations uniting to develop innovative technologies in the South West.

The Assisted Living Action Network (ALAN) is a platform for businesses, healthcare professionals, service user groups and academic researchers to stimulate the development of innovative assistive living products and services in the South West.

Membership is free!

Through hosting quarterly networking seminars we aim to:

- Facilitate discussions on areas of unmet need
- Promote knowledge transfer collaborations between research institutions and industry
- Create commercial opportunities for new assistive technology products and services

Sign-up to join the network to receive regular newsletters and updates. Members also benefit from invites to ALAN networking seminars.

Next event:
Beyond ‘Talking the Talk’ and ‘Walking the Walk’
Thursday 20 July 2017